AGRICULTURAL Research

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MEASURING PROTEIN QUALITY, Page 8

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Atoms at Work

Atoms work hard for agriculture.

Radioactive isotopes, serving as tracers, are unlocking a wealth of knowledge about soils, plants, and animals. Like tiny radio stations, these atomic tracers beam steady waves that signal the movement and location of the radioactive atoms. An array of radiation-detecting instruments enable scientists to readily follow their motion, both through inert laboratory experiments and living organisms.

Although radioactive isotopes were not widely available for research purposes until after World War II, almost 65 years ago a USDA scientist, W. H. Ross, tested their effects on plant growth. Before joining USDA, Ross and a colleague found two radioactive elements with which they were working to be chemically identical—a finding that was an immediate forerunner to the discovery of isotopes.

Isotopic tracers have since been compared in importance and character with the microscope. Versatile and sensitive, this diagnostic tool bares secrets that otherwise would be difficult to learn, if at all. Chemists, for example, use tagged atoms to study the degradability and fate of pesticides. Soil scientists employ isotopes to study sediment transport and the intricacies of the nitrogen cycle. Entomologists use them to unravel the mysteries of an insect's feeding, migration, and hibernation habits. Plant physiologists have a better understanding of photosynthesis and have learned how plants use carbon to manufacture food. And animal physiologists know more about egg production, milk secretion, the physiology of reproduction, and digestion and metabolism of vitamins, minerals, and nutrients.

In the long run, the new insights that radioactive isotopes provide into the functioning of living organisms may prove most vital. For germs are no longer the prime enemy of life. Today we are more concerned about diseases—like arthritis and cancer in people and livestock—in which the organism's inner balance is upset. There is also concern about instability in ecosystems. To prevent these upsets, we must learn how the inner balance is maintained, whether in a healthy organism or a life system. In this quest, atomic tracers will be one of the scientist's chief allies.

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Clifford M. Hardin, Secretary
U.S. Department of Agriculture

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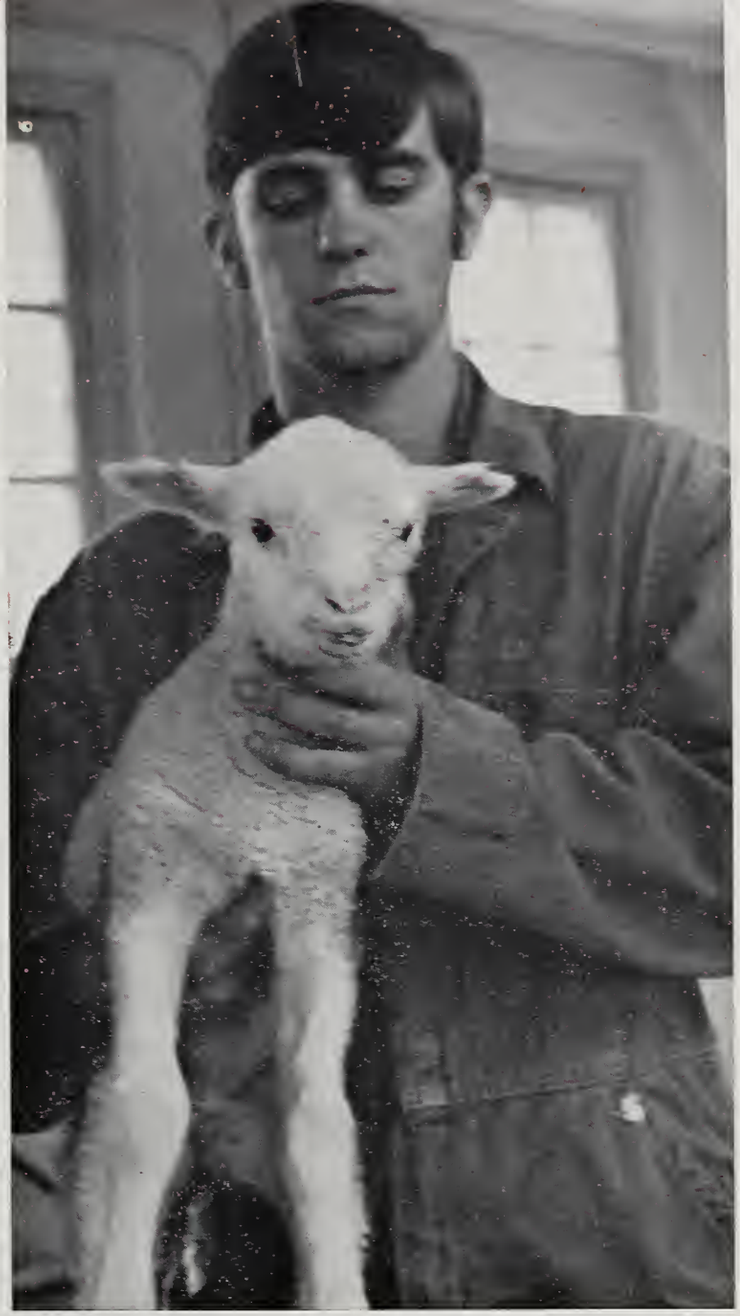
Agricultural Research Service

Cold Milk Pays Off



Assistant C. R. Bender carries crossbred lamb, one of the youngest in the group. These lambs seemed to have a stronger attachment to people than domestic lambs (ST–5204–5).

Crossbred Finnish Landrace lambs, among the first of their kind in this country, are making superior progress on cold milk formula.

Only one lamb in 68 was lost during the first 6 weeks on the cold formula, reports ARS sheep nutritionist I. L. Lindahl, Beltsville, Md. Usually, around 20 percent of the lambs left with their mothers die from various causes. A mother of twin lambs, for instance, may not have enough milk for both and one lamb may starve. In a prior experiment, a large proportion of lambs which otherwise might have died were saved with the aid of cold formula.

The crossbred lambs are the result of one of the first experiments to cross Finnish Landrace rams with American breeds of sheep. ARS geneticist G. M. Sidwell is conducting the project. The rams were imported from Ireland last year in an effort to incorporate the tendency of the breed for multiple births into our American breeds. Landrace ewes normally have an average of three and can have up to eight lambs per pregnancy compared to the average of 1.5 lambs for American breeds.

With the prospect of more lambs per ewe, an efficient system for raising "extra" lambs was needed. For this reason, Lindahl decided to raise the lambs on ice-cold formula (AGR. RES., Sept. 1968, p. 7). This is the

first time the formula has been used on a large scale, and he says the crossbred lambs have "taken" to it better than other lambs tested.

Average daily weight gain of the lambs is about 0.8 pound, compared with the 0.6- to 0.7-pound gain of lambs left on their mothers. The lambs are extremely vigorous and hardy. Lindahl says they just "don't give up" —even some of the weakest lambs have pulled through. He also noted that these lambs are friendlier and easier to handle than most American breeds.

The formula is EWELAC. It is circulated through a bulk tank to keep it at the desired 40° F. and fed free-choice in plastic containers with rubber nipples attached. Every 24 hours, the equipment is cleaned and sterilized, and the formula replaced with a freshly mixed batch.

Sidwell cautions that some of the excellent survival and growth by the lambs must be attributed to hybrid vigor, that extra boost that comes from crossing two entirely different breeds of the same animal. Even so, the researchers see prospects for commercial raising of lambs on the cold formula.

Research with the Landrace sheep is also underway at the University of Minnesota, St Paul, and at Clay Center, Nebr., and Dubois, Iowa. ■

Above: *Crossbred lambs drink cold formula from unit made by grafting nipples from commercial feeding pails onto large square polyethelene boxes (ST–5204–2).* ***Right:*** *Finnish Landrace ewe and twin lambs. Ewe gave birth when she was 14 months old; most domestic sheep don't lamb until they are at least 18 months and then only have one lamb (ST–5225–3).*

ULTRASOUND: A boon in Finnish Landrace Research

The ultrasound Doppler technique to detect pregnancy in sheep has proved a useful tool for predicting the lamb crop from crosses with Finnish Landrace rams.

The rams arrived late in the breeding season—after all available ewes at Beltsville, Md., had been mated to other rams. A nonpregnant group for breeding to the Finnish rams was selected from the ewes through the Doppler technique.

Since the ewes were bred to the Finnish rams so late in the breeding season, only 50 percent were estimated to be pregnant, says ARS sheep nutritionist I. L. Lindahl, who developed the pregnancy test. However, the Doppler showed 75 percent of the ewes to be pregnant. Pregnancy detection was made 75 to 109 days before the birth of the lambs or about 36 to 70 days after mating.

The lambs from these ewes were to be raised on cold milk formula, and extra equipment was needed to care for the larger number of lambs expected. ARS geneticist G. M. Sidwell, who is conducting the breeding experiments with Finnish sheep, expected 20 to 30 lambs. Sixty-eight lambs were born.

Lindahl said they could never have handled that large a lamb crop on cold formula without the extra equipment ordered as a result of the pregnancy detection test. Raising the lambs from birth on cold formula should permit their mothers to breed back at the normal time in the following season.

Bovine Emphysema

WHY SHOULD basically nutritious cattle feed sometimes cause bovine pulmonary emphysema, also called cow asthma?

Certain plants apparently become dangerous to cattle when, during an onrush of fast growth at immature stages, relatively high levels of protein and free amino acids build up inside them. Representative of these amino acids is tryptophan, which, when given experimentally to cattle, produced a disorder whose onset, course, and clinical signs were strikingly similar to those of natural emphysema.

The artificial disease is under study by Washington State University veterinarian E. O. Dickinson and ARS veterinarian J. R. Gorham at Pullman, Wash. The researchers hope that this work will eventually lead to clearer understanding of what happens in nature, pointing to methods of preventing, controlling, or treating natural emphysema.

Tryptophan is a curious suspect for causing "poisoning" because of its established role as an amino acid essential for proper protein production in animals. At present, researchers speculate that microbes in the rumen of cattle convert overdoses of free tryptophan into a side product that incites disease.

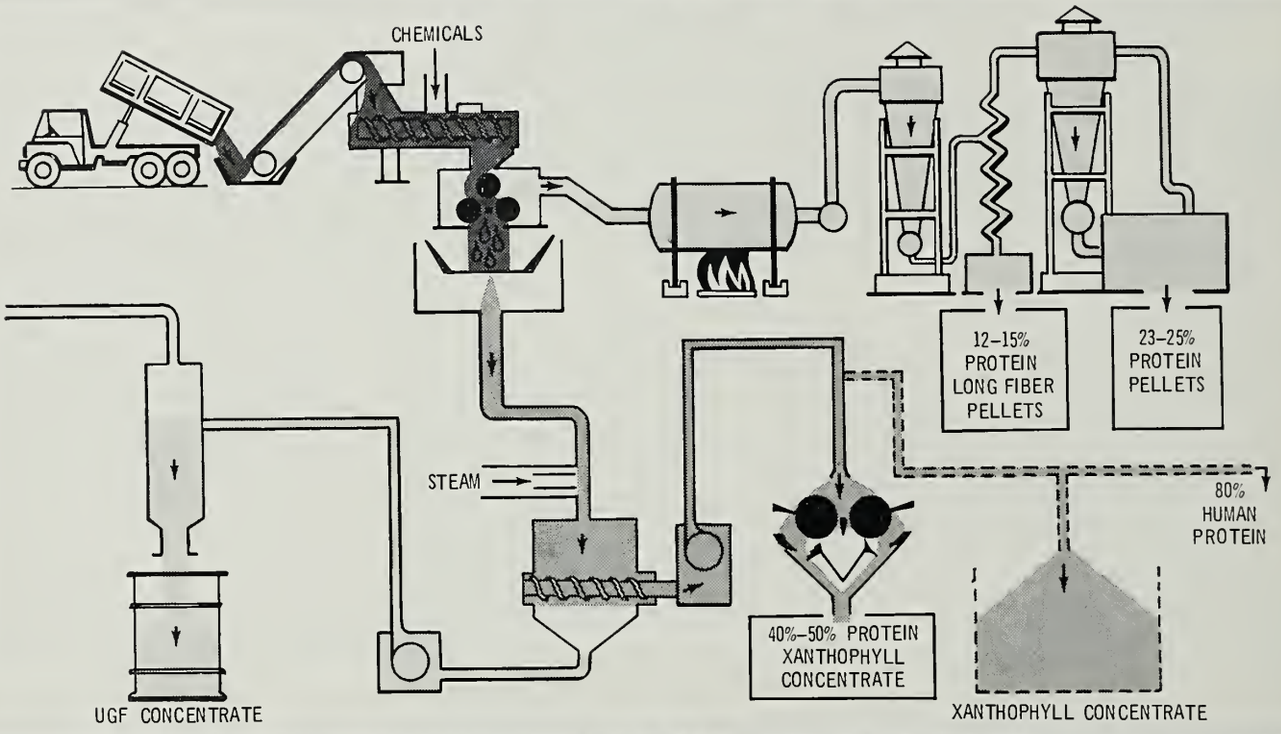
Understanding pulmonary emphysema is important, particularly to the range cattle industry, which annually sustains multimillion-dollar losses. Trouble typically occurs after a sudden change of cattle feed, such as a change from dry summer range to lush irrigated pasture. Another example is a move to pastures with a heavy growth of rape, kale, and other plants of the mustard family.

The research team believes that trouble starts when fluid seeps from the blood into delicate lung tissues. Fluid buildup interferes with respiration, causing labored breathing and leading to stretching and breaking of tiny air sacs in the lungs. Abnormal bubbles and pockets of air are trapped in lung tissue, worsening the breathing problem. Many affected cattle suffocate; survivors suffer weight loss and possibly permanent lung damage.

When the Pullman researchers dosed test cattle with pure tryptophan, the cattle began to show signs very similar to natural emphysema within 72 hours. External signs of trouble peaked on the fifth or seventh day, just as in natural disease. And postmortem studies further showed gross and microscopic changes in lung tissue strikingly similar to those seen in natural emphysema. ■

Curiously, the human diseases most similar to bovine emphysema do not include human emphysema. Rather, the cattle disease resembles asthma, when caused by allergies to pollen and the like; farmer's lung, caused by inhaling barn dust; or silo filler's disease, caused by breathing irritating gases. Research on artificial and natural bovine emphysema may lead to a better understanding of these human diseases.

BIG SQUEEZE



Field-chopped alfalfa received at the plant is fed via an auger to rolls which separate it into juice and cake. As the alfalfa moves through the auger, ammonia and an antioxidant are added to preserve nutrients and to make it easier, later in the process, to screen a curd out of the juice.

The moist cake from the rolls can be fed directly to cattle if the plant is near large-scale feeding operations. More likely, it will be sent through a dehydrator. The operator can then follow the conventional procedure and run dehydrated meal through hammer and pellet mills. But if he wants to tailor the product for end use, he will probably run dehydrated material through a leaf-stem separator, then pellet or cube the leaf and stem fractions separately. The coarse stem fraction would make good roughage for cattle feeding; the leaf fraction could be added to rations where less fiber is desired.

Meanwhile, the juice fraction is undergoing refinement. After it is squeezed out by the rollers, the juice is strained to remove fiber particles and then sent through a steam chamber. Steam causes protein, carotene, and xanthophyll in the juice to coagulate into a green curd which floats to the top of the liquid portion, a brown juice. The curd is taken away by an auger and conveyed to a drum dryer where it is converted into a protein-carotene-xanthophyll concentrate powder for poultry. The curd could also be conveyed to a solvent extractor to obtain human protein and a xanthophyll concentrate. The brown juice, a rich source of nutrients, is piped to an evaporator for concentration (PN–1819).

getting the most out of alfalfa

A NEW PROCESS sorts out the valuable substances in alfalfa according to most efficient use—high-protein food supplement included.

By separating the constituents and concentrating some of the more valuable nutrients, the process can tailor alfalfa to satisfy the more specialized feed requirements of today's agriculture.

Called the wet process, the method is now being refined and evaluated at the ARS Western utilization research laboratory, Albany, Calif. The research is under the direction of chemists G. O. Kohler and E. M. Bickoff, assisted by chemists R. R. Spencer, B. E. Knuckles, S. C. Witt, R. E. Miller, and chemical engineer A. Mottola.

Dehydration of the whole alfalfa plant is an attempt to preserve the unstable components of alfalfa. Over the past 40 years, dehydration has developed into an important industry, but it has shortcomings. Dehydrated alfalfa meal is fed mainly to cattle and poultry, and as presently made, is not ideal for either animal. It is a good source of protein, carotene, and xanthophyll for poultry, but to get these desirable substances, the poultry producer has to take something undesirable: a lot of fiber. The meal is too finely ground to be good roughage and its carotene and xanthophyll tend to give fat a yellow tint.

Finally, the present dehydration process does not meet an end use that could become critically important in the years ahead: direct utilization of the vast amount of protein in alfalfa for human food.

A key step in the new wet process is running fresh, chopped alfalfa through rolls to squeeze out a large volume of juice. From this juice a protein-carotene-xanthophyll concentrate is prepared and dried to a powder. This preparation is an ideal source of protein, carotene, and xanthophyll for poultry rations and is virtually free of fiber. It can be further separated into two products: a protein and a carotene-xanthophyll concentrate. The protein could become a good protein source for humans, and the carotene-xanthophyll concentrate is valuable for poultry feeding even without the protein.

Another fraction is the concentrated water-soluble nutrients in alfalfa, a brown liquid rich in amino acids, minerals, and unidentified growth factors. These substances benefit growth, health, and reproduction of poultry, swine, and ruminants, and the concentrate could be used as a liquid supplement or mixed with dry feed.

The rest of the alfalfa from which the juice has been extracted comes off the rolls as a moist pressed cake containing only slightly less protein, carotene, and xanthophyll than present commercial meal. This product can either be fed to cattle or dehydrated and processed further. By employing the air separation process developed earlier at the Western laboratory to obtain an improved high-protein, low-fiber meal (AGR. RES. July 1965, p. 7), the system could be further modified to separate the pressed cake into fractions precisely tailored to meet the requirements of various livestock rations.

The ARS scientists emphasize that the process does not necessarily "rob" from the traditional product, alfalfa meal. It is essentially a scalping operation, removing only enough protein, carotene, and xanthophyll to meet the need for a fiber-free concentrate for poultry feed, and leaving a dehydrated meal which would meet the manufacturer's standard of 17-percent protein. If the market demanded, the process could be adjusted accordingly and meals containing various protein levels produced. If the need to prepare large amounts of protein for human use became urgent, the nutrient level in the meal could be sacrificed.

Although the process is still under development, and some questions, especially economic, remain unanswered, the scientists report that encouraging progress is being made. Commercial scale evaluation of the air separation process has been completed, and it shows good commercial possibilities. The process is being installed in several plants in the United States. The new, wet process is now being evaluated commercially by the Batley-Janns Enterprises at their plant in Brawley, Calif., under terms of a "Memorandum of Understanding" with ARS. ■

Cover: Research associate F. P. Pascual mixes a volume of serum with antigen and incubates it with accessory factors to show the presence of antibodies (ST-5031-6).

Left: Associate professor M. A. Kenney weighs rat spleens (ST-5012-22). Right: Pascual prepares spleen cells for count of antibody-forming cells (ST-5013-13).

Sensitive new test measures

PROTEIN QUALITY

THE NUTRITIONAL VALUE of protein in the diet may be measured by the number of cells in the spleen that specialize in making antibodies, protein substances produced to fight off infection.

Scientists have shown a close correlation between the number of cells and the quality of protein: the better the quality, the more cells produced.

The ARS-sponsored research was conducted at Iowa State University, Ames, by scientists who pioneered in the use of antibody count to determine protein quality. Going one step further to measure the antibody-producing splenic cells instead has proved a more sensitive test.

In the study, adult male rats of the Wistar strain were depleted of protein for 5 weeks by receiving a diet containing 10 percent fat, 4 percent salts, 2 percent fiber, and 84 percent cornstarch, plus a daily vitamin supplement. A control group was fed the regular laboratory stock diet providing about 25 percent protein. Six days before autopsy, all animals were challenged to produce antibodies by intravenous injection of sheep red blood cells.

The scientists found that spleens of protein-deficient rats weighed only 60 percent of normal, and the splenic cells actively forming and supplying antibodies to the red blood cells were about one-third as numerous as those of rats fed a normal diet.

Total amount of antibody in the blood serum of the protein-deficient rats was estimated to be only about 30 percent of that in the control animals. This means that protein deficiency reduced antibody output to the same extent that it inhibited formation of the antibody-synthesizing cells in the spleen.

Because antibody production per antibody-forming cell in the spleen did not decrease in the protein-deficient animals, it is assumed that the decrease in amount of antibodies is caused by the reduction in the number of antibody-forming cells. This reduction is at least partly due to smaller spleens following protein malnutrition.

After demonstrating how protein quality relates to the number of antibody-producing cells, the Iowa scientists fed low-protein diets, with and without supplementary amino acids, to other rat groups to check the effect of three vegetable protein mixtures on antibody formation.

In this experiment, adult Wistar rats were depleted of protein for 4 weeks, then fed a diet containing one of the three vegetable protein mixtures. After 8 days, these animals were also challenged to produce antibodies by the injection of sheep red blood cells. They remained on the diet 6 more days, then were autopsied.

More antibody-producing cells were found in the spleen of rats fed a protein mixture containing 3.3 percent of the protein from rice plus 1.7 percent from mung beans than from a diet supplying 5 percent of the protein from rice alone. Blood antibody levels, however, were about the same on both diets, indicating the greater sensitivity of antibody-producing cells as a measure of protein quality. In diets containing 7.5 percent protein—5 percent from rice and 2.5 percent from mung beans—the number of antibody-producing cells in the spleen increased, as did the concentration of antibodies in the blood serum.

When rice was supplemented with an amino acid mixture similar to that supplied by mung beans, results resembled those of the rice-mung bean diet.

Both quality and quantity of protein also markedly affected growth and liver composition of laboratory rats.

Body, liver, and spleen weights all increased when rice was supplemented with mung beans or with amino acids. Liver fat decreased by half when rice was supplemented with essential amino acids in the 7.5 percent protein diet, but less so when mung beans were added to the diet. Concentration of nitrogen in the liver increased with supplementation at the 7.5 percent level, but not at the 5 percent level. Liver RNA (ribonucleic acid) increased with supplementation, but liver DNA (deoxyribonucleic acid) did not. ■

Antibodies are produced to fight off infection when a foreign protein substance, called an antigen, is introduced into the body. The ability to fight off infection is often referred to as immunity, which is developed in a complex process involving a number of steps not completely understood. Protein synthesis is the basis for each step, and protein in the diet, whether from plant or animal sources, is essential.

Above: Newly formed immunoproteins in the animal body have been marked with radioactive lysine. Professor of nutrition Lotte Arnrich prepares the marked immunoproteins for counting (ST-5014-16). Left: Graduate assistant Harriet McCoy determines nucleic acids in spleen and other rat tissues as a basis for evaluating protein synthesis in relation to cell division (ST-5012-11). Right: Laboratory assistant M. K. Cable dilutes serum for antibody determination (ST-5013-7).

sky eye on brown soft scale

DETECTING insect infestations by use of infrared aerial photography should one day restrict the need for time-consuming ground surveys and permit control while the pests are confined to limited areas.

ARS scientists point out that a remote sensing technique now used experimentally (AGR. RES., July 1969, pp. 8–11) would reduce by $2,200 the annual cost of checking just 20 Texas citrus groves for brown soft scale at monthly intervals.

The most serious pest of citrus in Texas, brown soft scale is so far the only fruit insect whose damage has been detected by remote sensing. Eventually, scientists say, remote sensing may identify insect damage that results in significant discoloration, defoliation, geometric distortion, or unusual deposits on the leaf surfaces of many crops.

Presence of brown soft scale and extent of infestation can be determined on aerial infrared photographs because a black sooty mold is associated with the insect. ARS entomologist W. G. Hart explains that this scale insect excretes large quantities of honeydew soon after it attaches itself to citrus leaves and stems. A saprophytic fungus develops rapidly on the honeydew, forming a dense black coating.

In laboratory experiments at Weslaco, Tex., Hart and former ARS agricultural engineer V. I. Myers showed that the mold reduces reflectance of mature citrus leaves. Spectrophotometer measurements indicated that leaves without mold had a reflectance of 58 percent at 770 millimicrons (mμ) and 53 percent at 1300 mμ. The reflectance readings on leaves heavily coated with mold were 9 and 23 percent at the same wavelengths.

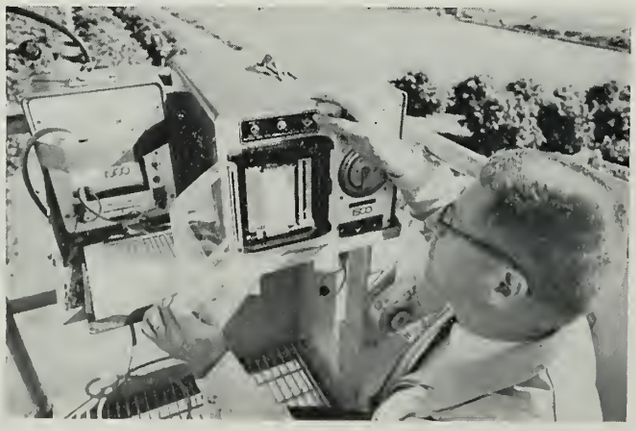
The scientists used this information in evaluating aerial color photographs of a grove where seasonal buildup of scale had been determined by monthly ground surveys. The photos accurately showed no damage in May, development of scale populations at two locations of known infestation in September, and heavy infestation at the same location in November.

In a scale control experiment at the cooperating Texas College of Arts and Industry Citrus Center at Weslaco, plots that were sprayed with insecticide and those left unsprayed were also readily identified in aerial photographs. One set of photographs taken in midseason, however, indicated no sooty mold in formerly infested plots that had not been sprayed. Ground inspection showed that native parasites introduced by Hart had greatly reduced the scale population.

The scientists have also made very preliminary studies on remote detection of other citrus insects.

Leaf damage caused by the Texas citrus mite when it inserts its mouthparts to feed causes a silvering of the leaf surface. Spectrophotometer measurements indicated that reflectance at 1,000 mμ was increased from 3 percent with very light infestation to 7 percent with medium infestation. But in aeriel photographs, the scientists have been unsuccessful in differentiating mite damage from other types of damage and from new growth.

Injury caused by the citrus rust mite, russeting of the fruit, and some browning of leaves, has not been indicated in infrared photographs. ■



Above: ARS soil seientist R. W. Leamer in aerial lift measures radiation reflected from citrus trees (ST–4703–20). ***Right:*** *ARS assistant Thomas Sapp operates magnifying stereoscopic viewer to scan aerial infrared film to find areas for more intensive study (ST–7406–24).*

Evaluating systems that RECYCLE RUNOFF

RECIRCULATING irrigation systems utilizing runoff water promise to reduce total water requirements on farms in many areas.

Such systems involve no extra labor but improve irrigation efficiency by saving runoff and cutting down on water purchases. They also provide the means of altering management practices to reduce deep percolation losses. The systems save money for the farmer and reduce nutrient and sediment contamination of streams.

ARS agricultural engineer J. A. Bondurant of the Snake River Conservation Research Center, Kimberly, Idaho, is analyzing the recirculating systems in that area to gather data for designing better systems with maximum economy and efficiency in the reuse of collected runoff water. The Idaho Agricultural Experiment Station is cooperating in the study.

Recirculating irrigation systems are composed of a runoff collection system, a storage unit, a pumping installation, and a return pipe. Four general types of systems are: (1) reservoir—water collected and stored for later use; (2) sequence—water applied to a lower-lying field; (3) return-flow—water returned to a field at a higher elevation; (4) cycling-sump—water returned immediately; little reservoir capacity needed.

Bondurant says that the most efficient use of water is from cutback irrigation used in conjunction with a reservoir system. In the cutback irrigation system, pumping from a reservoir is stopped after the field starts to produce runoff.

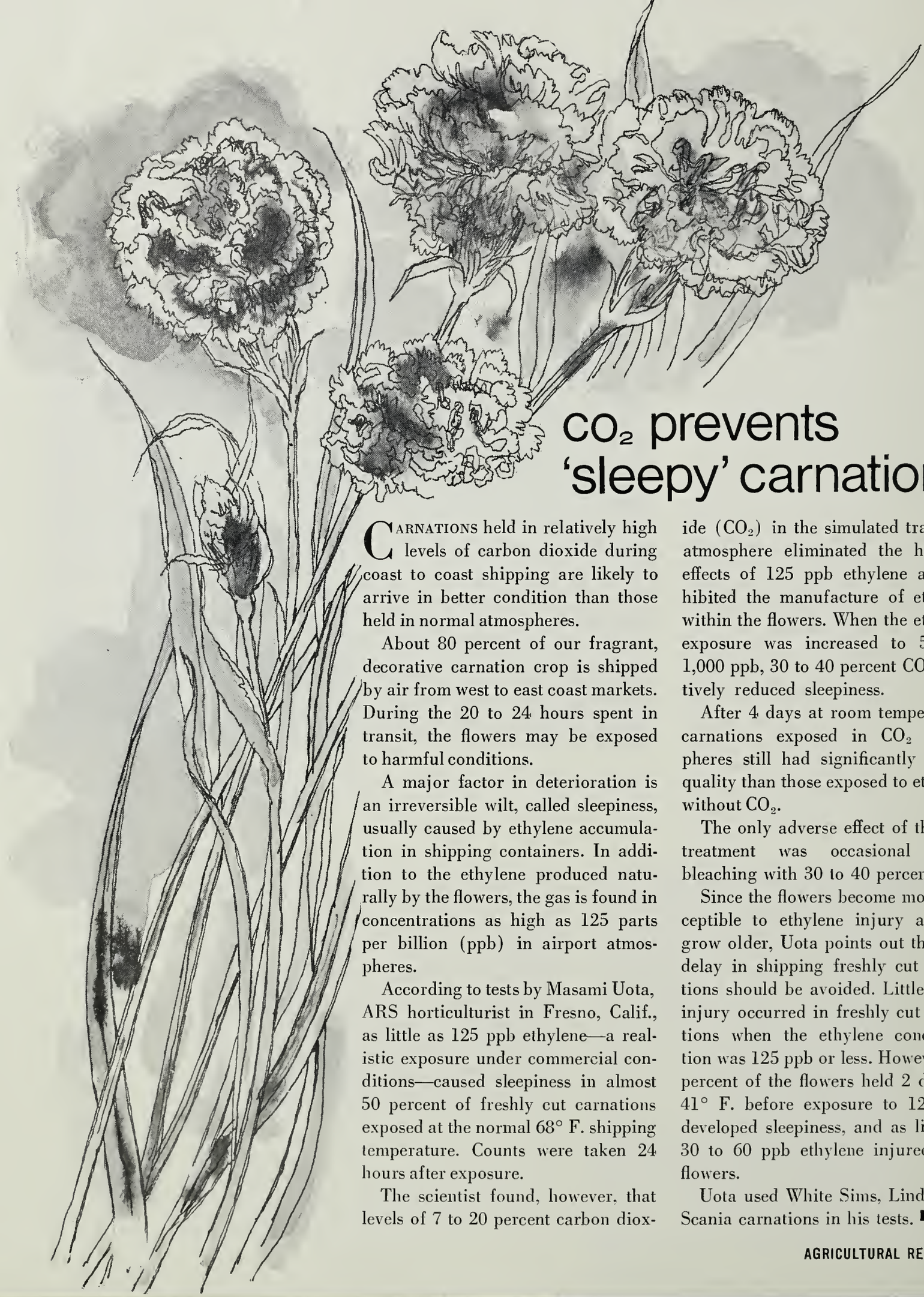
The large sump and pump above collects runoff water from about 80 acres and returns it one-half mile to the upper head ditch (BN–34220).

At the start of irrigation, stored water serves to beef up the stream flow from the water source. Large flows at the beginning of a set allow both the upper and lower ends of a field to get adequate water, and runoff is reduced so a minimum amount of water must be recirculated. With low flows at the start, water is wasted—it penetrates below the root zone at the upper end of the field and takes plant nutrients with it; the lower part of the field ends up with shallow penetration.

The economic value of the runoff water will be the deciding factor as far as many farmers are concerned. Where water is limited or where costs are high—as when pumped from wells—its reuse can result in a cheaper farm operation.

On farms using surface irrigation systems, excess water often serves as a substitute for labor. Reuse of irrigation runoff may be more economical than hiring additional labor to accomplish efficient irrigation.

Recirculating systems also offer advantages in irrigated areas where runoff from both surface and sprinkler irrigation is prohibited by law. In other areas, farmers may be more concerned with actual loss of water and soil. ■



CO_2 prevents 'sleepy' carnations

CARNATIONS held in relatively high levels of carbon dioxide during coast to coast shipping are likely to arrive in better condition than those held in normal atmospheres.

About 80 percent of our fragrant, decorative carnation crop is shipped by air from west to east coast markets. During the 20 to 24 hours spent in transit, the flowers may be exposed to harmful conditions.

A major factor in deterioration is an irreversible wilt, called sleepiness, usually caused by ethylene accumulation in shipping containers. In addition to the ethylene produced naturally by the flowers, the gas is found in concentrations as high as 125 parts per billion (ppb) in airport atmospheres.

According to tests by Masami Uota, ARS horticulturist in Fresno, Calif., as little as 125 ppb ethylene—a realistic exposure under commercial conditions—caused sleepiness in almost 50 percent of freshly cut carnations exposed at the normal 68° F. shipping temperature. Counts were taken 24 hours after exposure.

The scientist found, however, that levels of 7 to 20 percent carbon dioxide (CO_2) in the simulated transport atmosphere eliminated the harmful effects of 125 ppb ethylene and inhibited the manufacture of ethylene within the flowers. When the ethylene exposure was increased to 500 or 1,000 ppb, 30 to 40 percent CO_2 effectively reduced sleepiness.

After 4 days at room temperature, carnations exposed in CO_2 atmospheres still had significantly higher quality than those exposed to ethylene without CO_2.

The only adverse effect of the CO_2 treatment was occasional foliar bleaching with 30 to 40 percent CO_2.

Since the flowers become more susceptible to ethylene injury as they grow older, Uota points out that any delay in shipping freshly cut carnations should be avoided. Little or no injury occurred in freshly cut carnations when the ethylene concentration was 125 ppb or less. However, 99 percent of the flowers held 2 days at 41° F. before exposure to 125 ppb developed sleepiness, and as little as 30 to 60 ppb ethylene injured such flowers.

Uota used White Sims, Linda, and Scania carnations in his tests. ■

Delayed flowering cuts TUNG LOSSES

GROWTH RETARDANTS that delay tung blossoming look like a promising way to combat crop losses caused by late spring freezes.

At least, preliminary results are encouraging in experiments at the South Mississippi Branch Experimental Station, Poplarville. ARS plant physiologist J. T. Raese is conducting the research.

The first location for the work was in a low-lying area susceptible to late spring freeze damage. The branches of the test trees had developed an excellent crop of flower buds on the previous season's growth.

On March 6, 1968, growth-retarding emulsions and solutions were applied as a dip to the branches. On March 23 and 24, a freeze destroyed most of the flower buds in commercial tung orchards in the western part of the Tung Belt.

In the test area, the freeze also killed flower buds on untreated control branches and on those receiving an aqueous solution of the growth retardant Alar-50. But branches treated with naphthenic oil or naphthenic oil with Alar-50 blossomed during the first two weeks of May. Flowers on undamaged trees on higher ground outside the test area were in full bloom about April 16. Naphthenic oil was used to enhance the absorption of Alar-50 into dormant tung buds as well as to prolong dormancy itself.

Flowering appeared most consistent on terminal buds treated with 10,000 parts per million (ppm) Alar-50 in oil. Fruit set per flowering terminal was slightly higher on branches receiving oil and Alar-50 than on those with oil alone.

Differences in growth response clearly showed the delay effected by the treatment. Vegetative growth was in an advanced stage on the untreated branches when the branches treated with oil or oil and Alar-50 were still in the blossom stage. However, shoot growth of the treated branches caught up and was nearly equal to that of untreated branches by late June 1968.

Tests in 1969 were conducted on a larger scale in Monticello, Fla., and retardants were sprayed at 3 different dates beginning in January. Results showed that blossoming was delayed by several days and that greatest fruit set was obtained with the January 24 application of 10,000 ppm Alar-85 in 50-percent naphthenic oil. Fruit set per terminal was more than double that of untreated branches.

Lesser concentrations of oil and Alar-85 applied in February and March were not as effective in reducing frost damage and enhancing fruit set. Freezes on February 4 and 5 following nearly 3 weeks of warm weather may have contributed to the effectiveness of the January application, since by mid-December, the trees had already been under low temperatures long enough to meet the chilling requirement for spring blooming.

More information on dosage and timing is needed before recommendations can be made for grower use. ■

Top: *Tung flowers (N–14817) and nuts (PN–1820). Oil from nuts is used chiefly in quick-drying varnishes and paints.* ***Below:*** *Raese examines branch treated with Alar-50 and oil (PN–1821).*

Nobel laureate to give Atwater Lecture

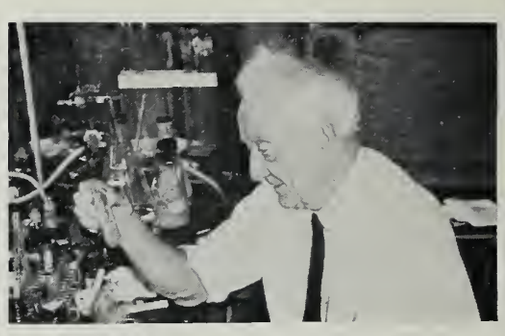
ALBERT SZENT-GYORGYI, Nobel Prize-winning biochemist, has been named this year to the Atwater Lectureship, the second in a series initiated and sponsored by ARS.

He will deliver the lecture September 10 in New York City before the American Chemical Society and under the joint sponsorship of the Biological Chemistry and Agricultural and Food Chemistry Divisions of the society. The title of his lecture is "Plant Immunity and Charge Transfer."

The Atwater Lecture series honors USDA's first chief of human nutrition research, W. O. Atwater. A forward-looking pioneer in nutrition research, Atwater was also the first director of the first State-supported agricultural experiment station (Connecticut) and the first director of the Federal Office of Experiment Stations.

Szent-Gyorgyi, Director of the Institute for Muscle Research at the Marine Biological Laboratory, Woods Hole, Mass., is one of the foremost molders of modern biochemistry. In 1937, he was awarded the Nobel Prize for Medicine and Physiology for his discovery and isolation of vitamin C from both plant and animal sources and demonstration of its essential functions. He continues to be an effective contributor to biochemistry and biodynamics.

Much of his work has been devoted to gaining an understanding of muscle contractile properties. He and one of his students recently furthered knowledge of muscle protein components.



Albert Szent-Gyorgyi (PN–1822).

Dr. Szent-Gyorgyi's nomination describes him as the "doyen of biochemistry . . . a man for all seasons with a refreshing and vigorous outlook."

Lecturers for the Atwater series are nominated by representatives of universities, national associations of educators and of scientists, foundations and medical societies. They are chosen for their outstanding contributions to the broad field of nutrition and the sciences it embraces. Last year's speaker was Nobel Prize-winning Finnish chemist, A. I. Virtanen. ■

Hakko Tofu: new food from soybeans

A NEW HIGH-PROTEIN FOOD with smooth texture and relatively bland flavor can be made from American soybeans.

Called hakko tofu, the food was developed through an ARS-sponsored Public Law 480 project in Japan, a heavy importer of American soybeans. The name hakko tofu is the literal translation of "fermented soybean curd," and the food can be packaged in bars, strips, or pieces of any desired size. In Oriental diets, it could be eaten as a snack or as a supplement to various courses of a main meal.

ARS sponsoring scientist C. W. Hesseltine says the nutritional value of the product, tested in experiments with rats, is better than that of traditional soybean foods. For example, hakko tofu has a protein efficiency ratio of 2.7 compared to 2.2 for just plain tofu. The ratio was calculated from the protein intake and growth rate as determined by weight gain of rats in a 21-day period.

Hesseltine, a microbiologist at ARS' Northern utilization laboratory, Peoria, Ill., says the Japanese followed a 3-step recipe in making this new food. The recipe involved a salt agglutinant to precipitate curd from soymilk, proteolytic enzymes to ripen the curd, and lactic acid bacterial starters to trigger and improve flavor. The plan of work was to achieve optimum conditions in each manufacturing step.

For superior curd preparation, T. Obara, principal investigator, found that a 1:420 ratio of calcium sulfate to soymilk at 158° F. provided the best chemical and temperature balance.

In their research on ripening agents, the Japanese experimented with several commercial enzymes including trypsin (animal origin), papain (from papaya), and the bacterial enzymes molsin, bioprase, and pronase. Trypsin and molsin proved impractical. Papain gave the best individual performance, but the investigators determined that a mixture of papain, pronase, and bioprase gave optimum results for faster ripening and improved texture.

For bacterial starters, the Japanese used a blend of half *Streptococcus cremoris* and half *S. lactis*, both nonpathogenic streptococci commonly found in dairy products and responsible for production of buttermilk and souring of milk respectively.

This project was conducted at the Department of Agricultural Chemistry of the Tokyo University of Education. ■

AGRISEARCH NOTES

Alfalfa Relatives Bring Resistance

Close relatives of alfalfa may prove valuable sources of resistance to the alfalfa weevil, which annually costs some $70 million in crop damage and control costs.

In studies at Beltsville, Md., ARS geneticist D. K. Barnes and entomologist R. H. Ratcliffe discovered several promising sources of weevil resistance in annual species of *Medicago* which are relatives of perennial alfalfa, *Medicago sativa.* The scientists tested 79 introductions of 16 annual species and found several with good resistance to egg laying, larva feeding, and adult feeding of weevils.

Continuing work will employ such methods as hybridization and embryo culture techniques to transfer genes for higher resistance from several of the annual species to perennial alfalfas such as the new, recently released variety Team. (AGR. RES., May 1969, pp. 8–9), Team has improved resistance to the alfalfa weevil, the pea aphid, and to anthracnose, *Stemphylium* leafspot, and common leafspot.

Lure Bags More Bollworms

Hexalure, an artificial sex attractant, lures males of a major cotton pest—the pink bollworm—better than the natural lure produced by females of the species, and also better than propylure, another synthetic attractant developed earlier.

Chemists Nathan Green and Martin Jacobson and entomologist J. C. Keller found that 0.002 ounce of hexalure has drawing power equal to that of 50 female pink bollworms when the lure is first placed in the field. Moreover, it retains its potency longer: After 5 to 7 days, hexalure attracted more males than either the live, caged females or their natural lure used by itself in traps.

ARS research assistant T. A. Campbell holds Team alfalfa; other plants are annual Medicago (ST–4870–13).

Hexalure also has another advantage: It costs less to produce and to use in the field than live insects or propylure.

Scientists discovered hexalure's potency in tests with 65 compounds chemically similar to the sex attractants of several species of moths. One of these compounds, *cis*-7-hexadecen-1-ol acetate, attracted male pink bollworms efficiently and was subsequently named hexalure.

Higher Rice and Soybean Yields

A five-year field experiment shows higher rice and soybean yields can be achieved with improved cultural practices and herbicide management.

In studying the effects of herbicides on yield and quality of rice and soybeans grown in rotation, agronomists R. J. Smith of ARS and R. E. Frans of the University of Arkansas, Fayetteville, recorded increases of as much as 9 percent in rice and 31 percent in soybeans.

They used propanil in postemergence applications to rice, and chlorpropham, swep, and O,S-dimethyltetrachlorothioterephthalate in preemergence treatments. In soybeans, they applied amiben or naptalam as preemergence treatments.

Barnyard grass, a major pest in rice, and several broadleaf weeds were effectively controlled by the herbicides. Though some of the chemical compounds were applied repeatedly, year after year, they caused no injury to either crop.

Both rice and soybeans produced higher yields in tests when grown alternately than when each was grown continuously. And the highest yields and the best weed control were achieved when herbicides were used and the crops rotated.

The established safety, effectiveness, and economic value of these practices in rice and soybeans strengthens the justification for continuing research to develop similar procedures for other crops.

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AGRISEARCH NOTES

Tailoring Cuts to Consumer

The most direct way of offering the consumer what he wants is to tailor cattle to produce the most possible retail cuts—"trimmed" meat ready for sale on the butcher counter.

The potential of such a beef breeding program was studied by ARS geneticist L. B. Cundiff and cooperators from the University of Illinois and the University of Nebraska. They analyzed the carcass data of several generations of cattle from many sources, thus incorporating a great variety of genetic background. Angus, Shorthorns, Herefords, and all possible crossbred combinations of these three breeds were included. Scientists restricted the breeding herd to cattle in the upper 38th percentile for pounds of retail cuts per day.

Results showed that after one generation, total production of retail cuts would go up by 0.6 percent and fat content would go down 0.6 percent if slaughter weight were kept constant. Time needed to produce such a carcass would be cut by 34 days, thus saving housing, labor, and feed cost.

Although selection for increasing total retail cuts shows promise, breeding can offer little toward increasing the proportion of highly desirable retail cuts, such as steaks, chops, and roasts. Calculations showed that the heritability of highly desirable cuts in the carcass is 20 to 30 percent less than heritability of total retail cuts.

Neither can bone content be reduced because this trait is closely tied to total retail cut production.

Heritability of retail cuts from wholesale rounds closely parallels that of all the carcasses retail cuts; examination of the round alone could serve in selecting beef cattle for high retail-cut production. Furthermore, there is a high negative genetic correlation between fat trim and retail cuts in the carcass, so that selection to reduce fat would be essentially as effective for increasing proportion of retail cuts as would direct selection.

Presently, neither analysis can be made quickly and at reasonable expense without killing the animals being examined. Researchers think, however, that increasing retail cuts from carcasses by selection shows enough promise to justify the necessary research to develop techniques for predicting the potential of breeding stock.

Sweet Sorghum: Obstacle Overcome

Sweet sorghum may become a new supplementary source of sugar because a practical way has been found to remove starch from sorghum juice.

For many years sweet sorghum has been eyed as a sugar source, but starch in the juice made sugar recovery either uneconomic or impossible. The amount of starch differs among varieties, but as sugar content goes up, so does starch content.

Starch is objectionable because conventional processes to recover sugar require temperatures near 200° F. At these temperatures the starch granules burst and thicken the syrup enough to sharply reduce or even completely prevent sugar crystallization.

The experimental process was developed by chemist B. A. Smith working at the ARS food crops laboratory in Weslaco, Tex. A public service patent has been obtained on the process and assigned to the Secretary of Agriculture for the free use of the public. The research is part of the Department's effort to find new and improved uses for agricultural products.

To remove the starch, Smith first adds limewater to make the juice from crushed sweet sorghum alkaline. He then adds a tiny amount of a polymer of acrylamide or other agent to cause starch granules to form clumps which can be settled out. This leaves a juice that can be processed much the same as sugarcane juice.

Sweet sorghum is an easily managed crop that requires little labor and little water. Yield is about 20 tons of stalks per acre and estimates of raw sugar content range from 180 to 230 pounds per ton of stalks.

CAUTION: In using pesticides discussed in this publication, follow directions and heed precautions on pesticide labels. Be particularly careful where there is danger to wildlife or possible contamination of water supplies.

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